

ART. IV.—NOTE ON THE STRUCTURE AND ARRANGEMENT OF THE MEDULLATED NERVE FIBRES IN THE GANGLIA OF THE POSTERIOR ROOTS OF SPINAL NERVES.

BY R. W. AMIDON, A. B., STUDENT OF MEDICINE.

SOME of the ganglion fibres present a peculiarity in which they are unique.

Early\* in my observations on the spinal ganglia of the frog, and later in those of the cat and dog, I often noticed what appeared to be branched, medullated fibres, and more careful study proved them to be such.

I thought I had made a discovery until I found in M. See's translation of Koelliker's Human Histology† that Remak, as long ago as 1841-'4, had noticed the same thing.

Koelliker says he has never seen this division of fibres, and speaks rather contemptuously of Remak's discovery thus: "Remak, on the other hand, *pretends* to have seen opaque (myelinic) fibres divide in the spinal ganglia of the ox." The original article of Remak's was not at my command, so I have no way of verifying Koelliker's statement.

In no other work do I see any reference to this discovery, and so, although Remak doubtless saw this bifurcation, the fact seems to have been ignored by later writers and observers.

Although my first finding of these dividing nerve fibres was accidental, the mode I pursued later with success was as follows:

Spinal ganglia taken fresh from a recently killed animal (the frog is best,) are incised or partly teased, to rupture the capsule, and placed in a 1 per cent. solution of hyperosmic acid.

After remaining from three to six hours in the acid, the specimens are removed, washed in distilled water, and put in glycerine.

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\* March, 1876.

† *Elements D'Histologie Humaine*, Paris, 1868, p. 419.

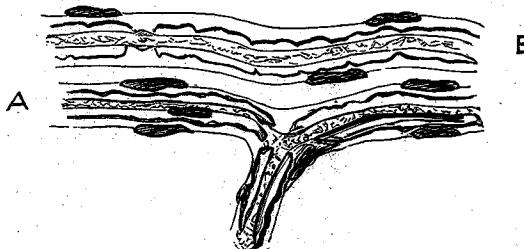
The acid hardens the nerve fibres, colors the nuclei of the membrane of Schwann brown, the myelin black, and the axis cylinder, it turns brown and somewhat granular.

To demonstrate the branched fibres, portions of the ganglia should be carefully teased with fine needles in glycerine. In this way I have obtained many fine specimens.

Success in finding the fibres will depend on the care and thoroughness with which the teasing is conducted. At one time I had three branched fibres within the field of a No. 6 Verick objective, (350 diameters.)

As I said before, the myelinic nerve fibres of the ganglion present the same characteristics as most other peripheral nerve fibres. They have the nucleated membrane of Schwann, the varicose sheath of myeline, interrupted at short intervals by the constrictions of Ranvier, and the granular, somewhat fibrillated axis cylinder.

The appearance the branched fibres present, I will endeavor to describe with the aid of the figure.



A large sized medullated nerve suddenly drops its myelinic coat, and leaves its axis-cylinder alone in the sheath of Schwann.

A slight swelling of the axis-cylinder is here noticed, and it immediately divides into two cylinder-axes, which, after each receives a myelinic sheath and a continuation of the membrane of Schwann from the parent nerve fibre, pursue a course almost diametrically opposite to each other, and generally at right angles to the parent fibre.

The peculiarities of this division are these:

1st. The sheath of Schwann continues on unbroken.

2d. The myeline is completely interrupted as at the constrictions of Ranvier.

3d. The enlargement of the axis-cylinder previous to its division corresponds to its enlargement at Ranvier's constrictions.

4th. The axis-cylinder of each resulting nerve fibre is almost as large as that of the primitive nerve fibre. For these and other reasons, it would seem sometimes as though the axis-cylinder of one fibre joined the axis-cylinder of another at the only vulnerable point, *i. e.*, a constriction of Ranvier."

Often seeing cell fibres take a peripheral direction and join the bundles of different sensitive fibres I at first thought with Koelliker, that the cell fibres were simply mingled with the sensitive fibres and with them pursued a centrifugal direction.

When I found the branched fibres, however, my views changed. Being all the time an advocate of a—and uni-polarity, it now dawned upon me that I had found the long-sought manner of connection between the cells and the fibres of the posterior root.

It now seemed to me that the so-called parent fibre was the cell fibre (or process) and that it either bifurcated, sending one of its branches into the cord and one out to the nerve, or that the cell fibre joined a sensitive fibre, while traversing the ganglion, at a constriction of Ranvier.

My views on this point were still more strengthened by reading a paper by M. Holl, on the structure of the spinal ganglia\* which, although written to support the bipolar theory is, I think, a strong argument in favor of unipolarity, and with my demonstration of branched fibres, I think, makes the connection between cells and sensitive roots very plain.

M. Holl, after giving the views of other observers on the subject, proceeds to give his own, based on an enumeration of the afferent and efferent fibres of the ganglion. He counted the nerve fibres of the motor and sensitive roots and compared their sum with the number of fibres in the nerve trunk formed

\*Ueber den Bau der Spinalganglien. Von M. Holl. Aus dem LXXII. Bande der. *Sitzb. der k. Akad. d. Wissensch.* III. Abth., Juli Heft., Jahrg. 1875.

by the union of the motor and sensitive root, external to the ganglion.

The results of his enumeration are very satisfactory.

In counting the fibres of four different ganglia in the frog, he made a difference of two in the first, eleven in the second, twenty-three in the third, and thirteen in the fourth, between the sum of the fibres in the motor and sensitive root, and the fibres in the nerve trunk.

To make his experiment more sure, he counted the fibres of a cat's ganglion also, and made differences of only two and fifteen, and this too, where the whole number of fibres amounted to over one thousand.

He says that he thinks these small differences were due to errors in counting, not to real inequalities.

He intended to prove first, by his investigations, that no more fibres emerged from, than entered; second, the cells are bipolar and one of the cell fibres goes centrifugally (outward) while the other goes centripetally (to the cord).

The former, he does prove conclusively, if his counts are correct; but the latter, he does not prove.

Many cells are seen to give origin to one fibre (only), which passes outward mingling with the sensitive fibres. Holl, by his investigations, tries to prove that unipolar cells cannot exist, because then the efferent would exceed the afferent fibres in number. He maintains that all cells are bipolar, and that one pole goes in (to the cord) and one out (to the nerve).

Considering the cells unipolar, I think the matter is easier of explanation.

The one process of a unipolar cell becomes a medullated nerve fibre, which in its peripheral course, either joins a fibre of the posterior root or bifurcates, one-half going to the cord and the other to the nerve. Looking at it in either way, it is easily seen that the number of the afferent and efferent would be exactly equal.